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Issued January 4, 1913.

United States Department of Agriculture,

BUREAU OF SOILS—CIRCULAR No. 75.

MILTON WHITNEY, Chief.

UNITED STATES DEPARTMENT OF AGRICULTURE,
Washington, D. C., October 26, 1912.

SIR: I have the honor to transmit herewith the manuscript of an article on Manganese as a Fertilizer, by M. X. Sullivan and W. O. Robinson, of this bureau, and to recommend that it be published as Circular 75 of the Bureau of Soils.

Very respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

MANGANESE AS A FERTILIZER.

By M. X. SULLIVAN and W. O. ROBINSON.

A review of the literature shows that numerous fertilizer experiments have been made with manganese compounds in water culture, pot culture, and in the field. The salts of manganese employed have been the dioxide, carbonate, iodide, nitrate, chloride, and sulphate, in quantities varying from 9 to 5,340 pounds, but usually less than 100 pounds to the acre, especially of the more soluble salts. The results of the experiments have varied somewhat, but in a majority of the cases applications of not over 50 pounds of manganese salts to the acre have given increased yields of a variety of crops on widely different soils. The crops experimented with have been rice, peas, beans, vetch, oats, wheat, barley, corn, potatoes, sugar beets, carrots, mustard, cabbage, onions, radishes, apricots, tobacco, and grass. Its action on rice and the leguminous crops seems to be more favorable than on corn, carrots, sugar beets, barley, potatoes, and tobacco. In many cases the increase has been very appreciable; upward of 25 and 30 per cent. In a number of instances no increase has been obtained. Large applications of manganese salts—that is, more than 75 or 100 pounds to the acre—have in general been found injurious.

It should be borne in mind that in all cases but one the experiments referred to have been made abroad. At the Arizona Experiment Station, however, it was found that manganese chloride stimulated the formation of potato tubers. Considerable work has

been done in this bureau on the fertilizing value of manganese salts. The detailed results of this work will be published in the near future.

Experiments on the after effects of manganese as a fertilizer are too few to warrant any definite conclusion. Some Japanese work, however, indicates that the ultimate after effect is not favorable.

The stimulating effect of manganese on plant growth is due most probably to its oxidizing activity and its influence on the oxidizing power of plants, microorganisms, and soil. In connection with plants manganese has been shown, through work in this bureau, to be the most active element in promoting oxidation changes brought about by the oxidizing enzymes. It has been found, too, that in general the power of soils to oxidize easily oxidizable substances, a power which is greater in fertile soils than in infertile soils, and in surface soils than in subsoils, is correlated with the manganese content and the nature of the organic matter. In this connection it is interesting to note that in a chemical examination of a number of soils and subsoils the manganese was found concentrated in the surface soil. In addition to furthering the necessary oxidation changes in plant and soil, it has been found by a number of investigators that manganese stimulates the growth of microorganisms, modifying their number and functions with a consequent modification of biochemical activities. As a result there is a change in both the quantity and the condition of various soil constituents. Further, it has been found that manganese added to the soil increases the absorption of other ingredients by the plant, particularly lime and magnesia.

Manganese is widely distributed in the soil. Of 26 American soils that have recently been carefully analyzed by one of the authors, all contain manganese (MnO) in proportions ranging from 0.01 to 0.51 per cent. The average content in these soils is 0.20 per cent, or about 8,000 pounds in the acre-foot. This amount compares favorably with that of phosphoric acid, though the quantity of phosphoric acid assimilated by the plant is very much greater.

In several soils, in Hawaii and in New South Wales in Australia the natural manganese content is so high that it has been found injurious to pineapples and grass, respectively.

Manganese is present in the soil in at least two forms; one the undecomposed silicate compounds, and the other manganese dioxide (MnO_2).

Of the various compounds of manganese, the dioxide seems to be the least effective, perhaps because the manganese is already present in the soil in this form. The sulphate has received the most attention and has given the best results. Less work has been done with the chloride, but in common with the sulphate, in small amounts, it

has produced increased yields. In large amounts both have been more toxic than the dioxide or carbonate. In a number of cases, even in very large amounts, the carbonate has given beneficial rather than injurious results.

In this country little work has been done on the value of manganese as an accessory fertilizer. Before any recommendation can be made as to its value in general farm practice, pot and field experiments must be made with a variety of crops on widely varying soils and under different climatic conditions.

Manganese for fertilizer purposes should not be expensive, since manganese sulphate, according to the English quotations, can be bought for about $75 a ton.

The application of manganese salts, of which the sulphate seems to be the most effective, should not exceed 100 pounds to the acre, and probably better results would be obtained from smaller quantities. Such small amounts can not be applied effectively to the soil unless ground fine and intimately mixed with comparatively large amounts of some other material, such as commercial fertilizers or barnyard manures.

The soil is complex and the seat of vast chemical, physical, and biological actions which are varying and differently modified by the addition of fertilizer ingredients. In view of this complexity and the discrepancy that has been found in the use of manganese fertilizers, manganese can not now be recommended in any way other than in experimentation and as a fertilizer complementary to the usual chemical fertilizers, nitrate, phosphoric acid, potash, and lime.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *October 30, 1912.*

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